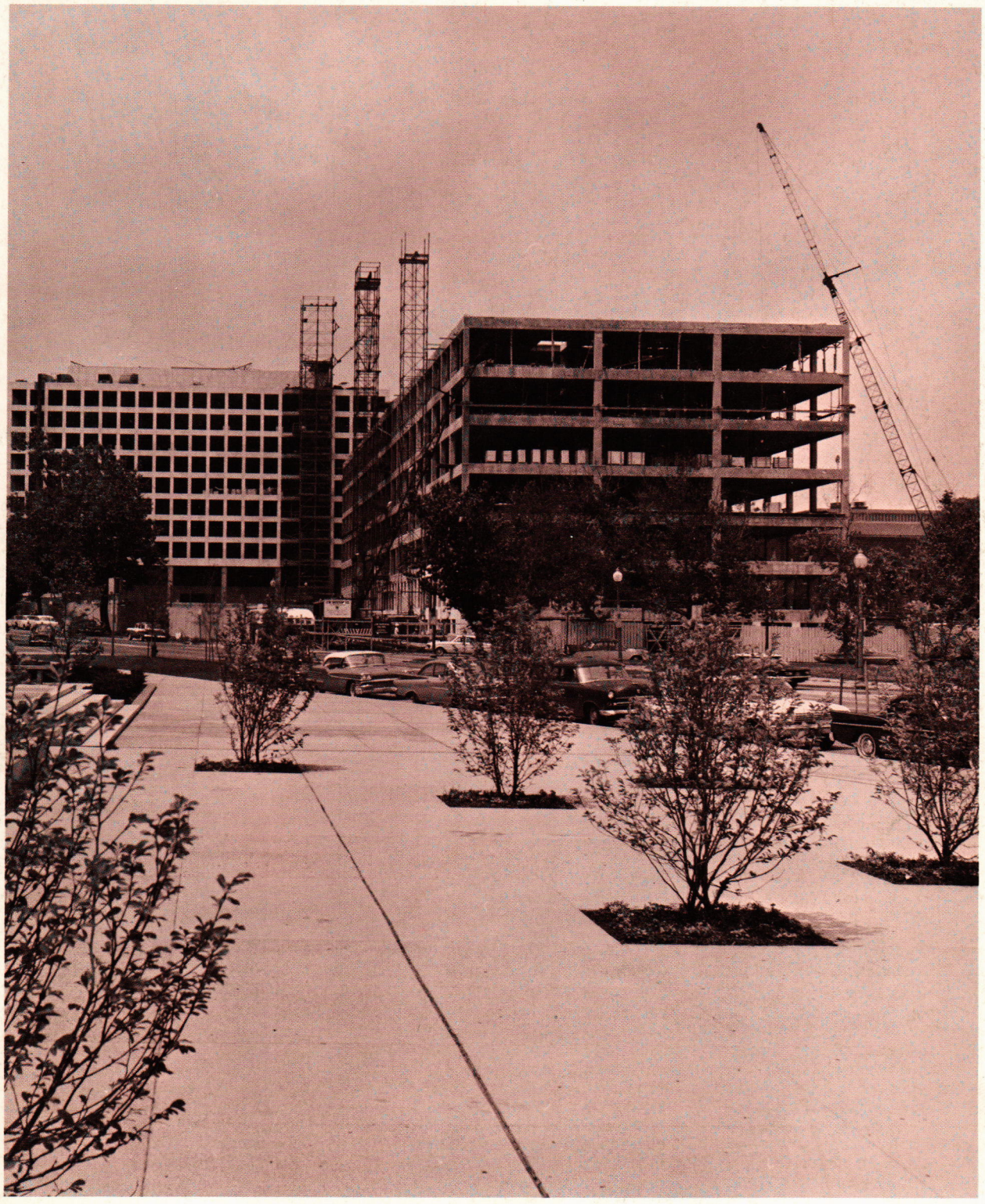
the Mechelecty

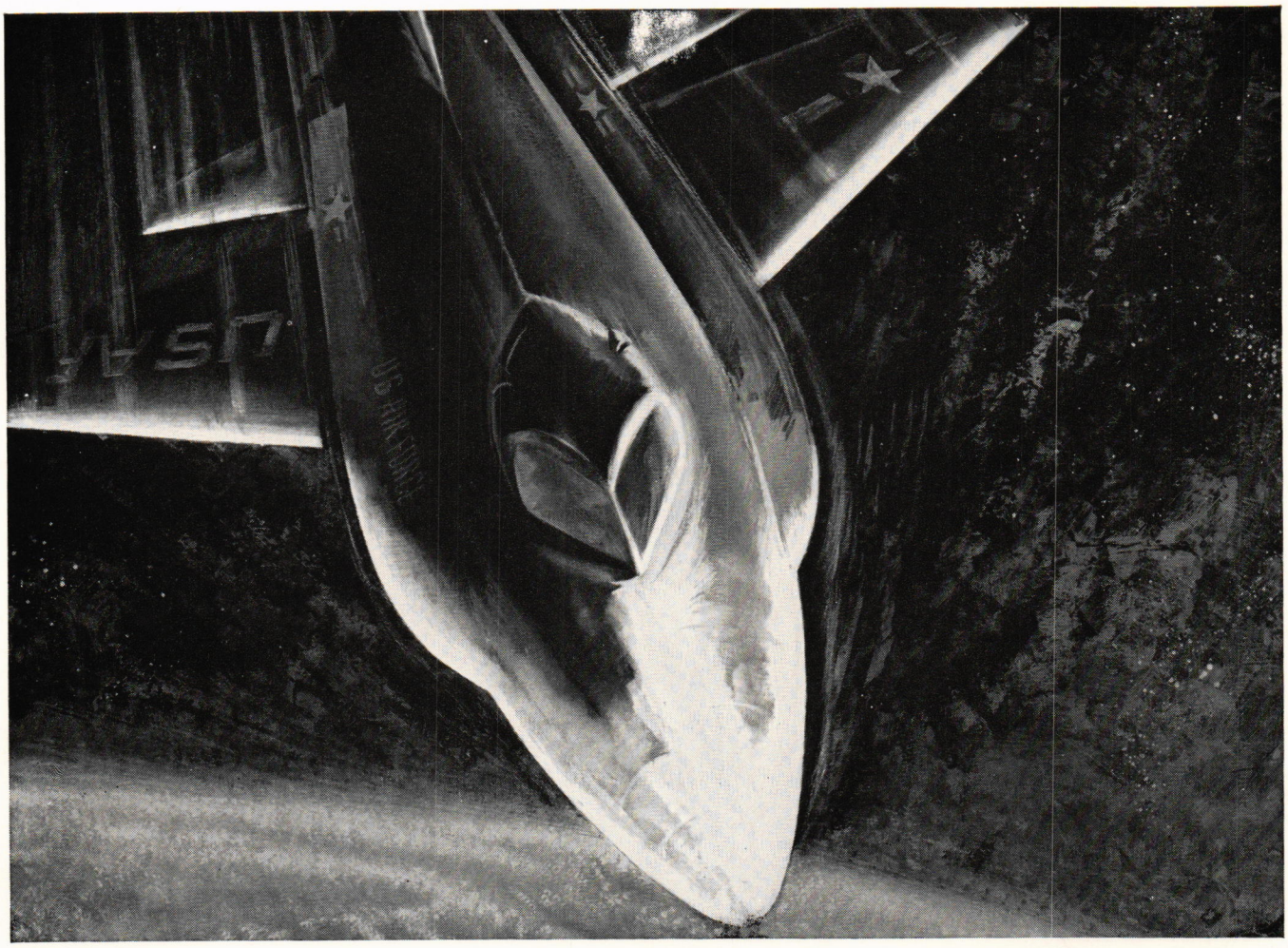
VOLUME 21 NOVEMBER 1962 No. 2

THE GEORGE WASHINGTON UNIVERSITY SCHOOL OF ENGINEERING



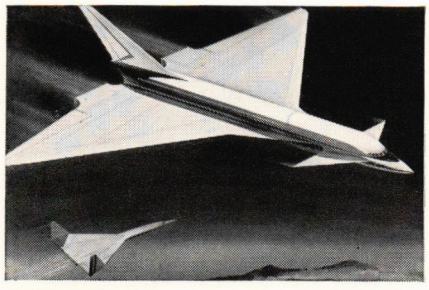
THE GEORGE WASHINGTON UNIVERSITY

NOVEMBER 1962

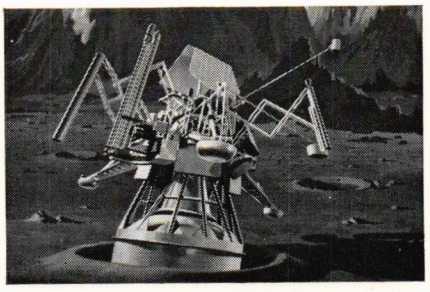


X-15—the famed research rocket plane that has reached speeds over 4000 mph and altitudes of 314,000 ft. Re-entering the atmosphere on the way back home, friction can make it glow like a red hot poker. The intense heat on the surface of the ship would soften and weaken materials normally used in aircraft construction. What kind of metal can be counted on to stay strong at the red heat of re-entry? Engineers found the answer to this difficult problem in a Nickel-containing alloy strong enough to resist sizzling temperatures of 1000 degrees, and more.

How Inco Nickel helps engineers make new designs possible and practical



2000 mph airliner—a supersonic jet that will fly from New York to London in just over 2 hours at speeds of 2000 mph, and at 70,000 ft. altitudes. What will hold her skin together? Logical choice: a brazing alloy containing palladium (one of the 14 elements produced by International Nickel), providing great strength at high temperatures—up to 630° F—caused by supersonic speeds.



Moon crawler. Sometime during 1964, this spider-like object—the "Surveyor"—is expected to land on the moon's surface and transmit information to earth on what the moon looks like and what it is made of. What metal will this machine need to withstand the extreme cold? Most likely a Nickel-containing alloy to provide toughness at sub-zero temperatures.

Today's engineer is aware of the advantages of Nickel-containing metals. He knows that Nickel, or one of its alloys, can make hundreds of new designs – from the strong, heat-resistant skin of a research rocket plane, to the complex parts of a moon surveyor—perform better and last longer.

You'll find Inco's List "A" helpful and informative. It has descriptions of 200 publications, covering applications and properties of Nickel and its alloys. Write: Educational Services,

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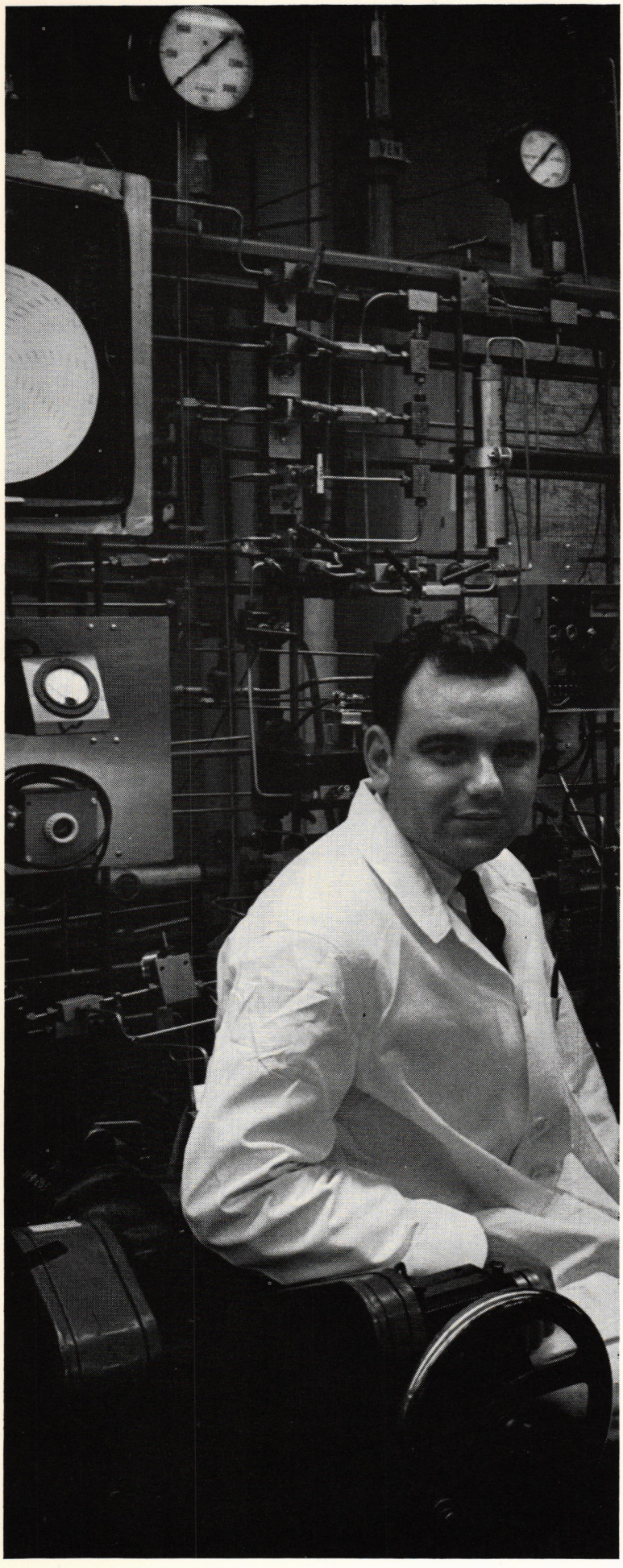

Variety: the spice of life at American Oil

by Jim Koller

"When I was first interviewed by American Oil representatives I was told I'd be given a free hand in guiding a wide variety of projects. This promise has certainly been kept!"

Jim Koller, 25 years old, came to American Oil right out of the University of Wisconsin where he earned his Bachelor of Science degree in Chemical Engineering. An Evans Scholar at Wisconsin, Jim describes his job at American Oil this way: "I work on basic chemical engineering problems, specializing in reactor design and process development problems. Before a process can go commercial, it must be tested in pilot plants. That's where I come in." Jim wants to stay in the technical research area, and plans to enroll in the Illinois Institute of Technology night school for courses in advanced mathematics.

The fact that many gifted and earnest young men like Jim Koller are finding challenging careers at American Oil could have special meaning for you. American Oil offers a wide range of new research opportunities for: Chemists—analytical, electrochemical, inorganic, physical, polymer, organic, and agricultural; Engineers—chemical, mechanical, metallurgical, and plastics; Masters in Business Administration with an engineering (preferably chemical) or science background; Mathematicians; Physicists.

For complete information about interesting careers in the Research and Development Department, write: D. G. Schroeter, American Oil Company, P.O. Box 431, Whiting, Indiana.

IN ADDITION TO FAR-REACHING PROGRAMS INVOLVING FUELS, LUBRICANTS AND PETROCHEMICALS, AMERICAN OIL AND ITS AFFILIATE, AMOCO CHEMICALS, ARE ENGAGED IN SUCH DIVERSIFIED RESEARCH AND DEVELOPMENT PROJECTS AS:

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AMERICAN

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Editorial Page

LEAD OR FOLLOW

Recent participation in the extra-curricular activities of the School of Engineering and Applied Science heartens any interested observer. For the first time in many years, room 200 of Tompkins Hall was filled to capacity for an Engineers' Mixer. The professional societies show marked gains over last year and participation in Mechelecіv has been on an upsurge. Interest in the Engineers' Council has increased and the engineering fraternities have observed considerably increased participation.

The new members in these organizations should begin now to consider seriously the rewards from holding offices of responsibility and the need of such participation. Being an officer in any organization grants an opportunity to benefit in several ways.

Professional competence is given a considerable boost from experience gained in such a capacity. Of course, some time will be consumed, but the future rewards will be considerable. Surveys have shown that the "face in the college crowd" falls far below the leader in potential earning power. Acquiring facility in leadership is an important part of a college education. To benefit fully, one must spend time working with others to achieve a common goal. The results will be gratifying, as any organization leader will be certain to point out. Those students who are not officers should, by all means, take advantage of the opportunity to seek offices and positions of leadership.

The need for participation is emphasized by the unfortunate fact that fifty major offices of engineering activities are filled by fewer than twenty-five students. This condition results in inefficiency because a person who holds several offices cannot do proper justice to any of them.

In part, this situation has resulted from a noticeable disinterest in activities last year. However, there are obvious advantages in accepting several concurrent offices. Holding several positions clearly indicates qualities desirable to potential employers. Therefore, the responsibility for providing an adequate number of qualified candidates can be expected to fall as much on the memberships of activities as on their officers.

It is hoped that a sincere effort will also be made by the present officers to diversify the positions of leadership to the less active majority. An effort of this type, given adequate response, will do much for all members of the School of Engineering and Applied Science.

--DLJ

the Mechelectiv

VOLUME 21 NOVEMBER 1962 No. 2

ARTICLES

DEPARTMENTS

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ALUMNI DEVELOP

Francis L. Hermach, is an electrical engineer in the electrical instruments section of the National Bureau of Standards, U.S. Department of Commerce. His principal field of research is the development of extremely accurate transfer instruments which make possible a-c measurements over a wide range of frequency, current and voltage.

A member of the NBS staff since 1939, Mr. Hermach received the Department of Commerce Silver Medal for contribution to standardization of electrical measurements in the development of a highly accurate transfer instrument for measurements.

Mr. Hermach received his B.E.E. degree from George Washington University in 1943. He is a member of the American Institute of Electrical Engineers, the Institute of Radio Engineers and the Instrument Society of America.

Convenient, rapid, and accurate measurement of a-c voltages can be made with a differential thermocouple voltmeter (DTVM) developed by James Griffin and Francis Hermach at the National Bureau of Standards. This instrument indicates directly in percent the corrections to be applied to the indications of the voltmeter under test. The DTVM is accurate to 0.05 percent over the voltage range of 1 to 700 v within the frequency range from 5 c/s to 10 kc/s. It can also be used to make ac-dc difference measurements (frequency response tests) to 0.02 percent.

A basic problem in electrical standardizing laboratories has been making accurate a-c measurements in terms of the fundamental electrical units, which are based on d-c standards. Efforts to solve this problem have brought about the development of transfer standards -- instruments which have the same response on both direct and alternating current. Although transfer instruments have been used successfully, they have been cumbersome and their operation has required much time and effort. Also, they suffer from various limitations. Electrodynamic and electrostatic instruments, for example, are capable of highly accurate measurement when used as transfer instruments, but are limited in frequency response or in voltage range. At 1000 c/s, appreciable errors develop in an electrodynamic instrument, and above 2000 c/s the instrument is no longer useful.

In recent years, highly accurate measurements have become necessary throughout the entire audio-frequency range used in the electronic industry. Thermocouple voltmeters are useful over wide frequency and voltage ranges, but are relatively unstable. The use of ac-dc transfer techniques has overcome the instability of thermocouple instruments, but this transfer ordinarily must be made for each measurement if an accuracy better than 0.1 percent is required.

For the differential thermocouple voltmeter developed at the Bureau, calibration adjustments need be made only about twice a day to maintain a stability of 0.01 percent. As a result, accurate a-c voltage measurements may be made with substantial savings in time and effort.

The DTVM includes two 10-ma thermoelements of negligible ac-dc difference. An adjustable resistor is connected in series with each thermoelement, so that the total heater resistance can be adjusted to exactly 100 ohms. An operating current of 10 ma was chosen so as to develop a voltage drop of 1 v per 100 ohms.

Figure 2. *J. E. Griffin is adjusting the resistance of one of the thermoelement heater-resistor combinations of the differential thermocouple voltmeter developed at the Bureau. The DTVM is used to make convenient, rapid, accurate calibrations of other a-c voltmeters, such as the one in the left foreground. It can also be used to make frequency response tests. The correction to be applied to the instrument under test when used at the test setting is read directly on a built-in galvanometer.*

CALIBRATION STANDARD

One of the two thermoelement heater-resistor combinations is connected in series with a decade resistor, which is marked to give a direct reading in volts, and is supplied by the voltage to be measured. The other thermoelement heater-resistor combination is connected to a stable d-c voltage source (a zener diode energized by a rectified and filtered a-c voltage). The outputs of the two thermocouples are connected in opposition through a galvanometer. The galvanometer indicates in percent the difference between the two thermocouple output emf's and has a resolution better than 0.01 percent.

When the DTVM is in use, the instrument under test is connected in parallel with the input terminals of the DTVM and with a voltage supply. The dials of the decade resistor are set to the nominal value of the voltage to be measured. The voltage supply is then so adjusted that the instrument under test indicates the same value of voltage as that set on the resistor dials. The galvanometer then indicates the correction to be applied when the instrument under test is used at this setting.

Several calibration adjustments are provided to ensure that at the operating current level (10 ma), the thermoelement heater resistances (100 ohms) are equal and that the thermocouple output emf's are equal for equal heater currents. These adjustments do not require reference to external standards, are easily and rapidly made, and ordinarily are required only about twice a day.

The reference current is established by connecting the input to a known 1-v d-c source and adjusting a resistor in series with the zener diode until the galvanometer is balanced.

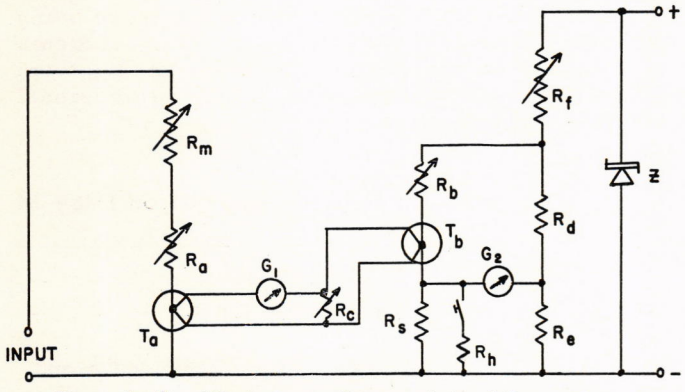
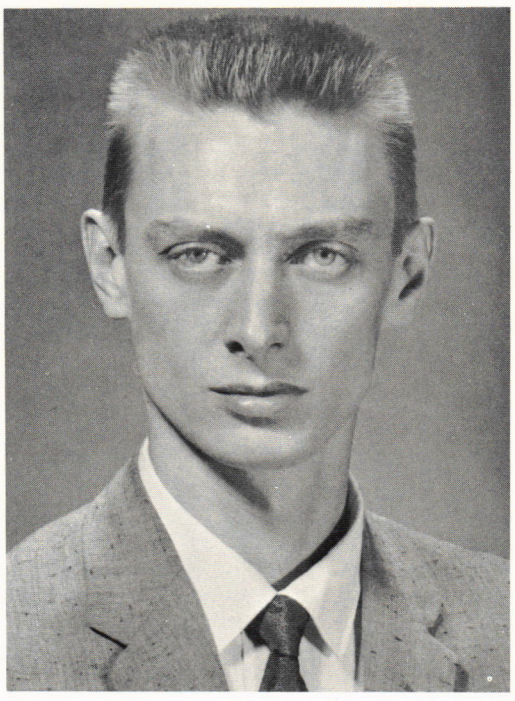


Figure 1. *Simplified circuit diagram of the differential thermocouple voltmeter developed at the National Bureau of Standards for rapid calibration of other voltmeters. T_a and T_b are the two thermoelements. R_m represents the decade resistor on which the nominal value of the input voltage is set. G_1 is the normal operating position of the galvanometer. R_h is used to check the galvanometer sensitivity. R_a and R_b is used to adjust the resistances of the thermoelement heater-resistor combinations to 100 ohms. R_c is used to adjust the thermocouple output emf's to equality. R_f is used to adjust the zener diode reference current to the proper operating level. R_e, R_d, and R_s are used in the internal calibration of the thermoelement heater-resistor combinations with the galvanometer in position G_2.*



James E. Griffin, a physicist in the electrical instruments section of the National Bureau of Standards, U.S. Department of Commerce, performs research in the field of energy measurements. His work involves the development, design and construction of instruments for accurately measuring the various electrical quantities such as voltage, current, power and energy.
A native of Benzonia, Michigan, Mr. Griffin received his B.S. in physics in 1956 from George Washington University. He is an Associate Member of the Institute of Electrical Engineers.
Mr. Griffin and his wife, Mary, reside at 4614 Randolph Road, Rockville, Maryland with their two children, James and Mary.

Because of the stability of the zener diode that supplies the reference current, this adjustment is necessary only about twice a year.

The Bureau's DTVM is a modification of an instrument in which a single-point potentiometer with a standard cell was used to adjust the d-c current through the second thermoelement. The use of a zener diode having better than 0.01 percent stability greatly simplifies the standardization circuits and makes possible a lightweight, more compact, and much more conveniently used instrument. The present DTVM is different in other respects also, and is useful to much higher frequencies.

Differentially connected thermoelements are now used in a commercially available transfer voltmeter having an accuracy of 0.02 percent. The resistors of this voltmeter are not calibrated, however, so that a d-c volt box and potentiometer are required for the measurements. A calibrated, 0.05 percent accurate a-c voltage source using differentially connected thermoelements has also been developed recently. The thermoelements are used in a feedback circuit with a zener diode as the reference.

CAMPUS NEWS

FLASH! THE FIFTY SEVENTH NATIONAL CONVENTION OF THE TAU BETA PI ASSOCIATION APPROVED THE ESTABLISHMENT OF THE DISTRICT OF COLUMBIA GAMMA CHAPTER AT THE GEORGE WASHINGTON UNIVERSITY ON OCTOBER 18, 1962.

ERLING R. JACOBSEN, PRESIDENT, SIGMA EPSILON
RAYMOND R. FOX, FACULTY ADVISOR, SIGMA EPSILON

SIGMA EPSILON

On 30 September 1962, at 4:00 p.m. in Tom Sarris' Steak House, the following people were initiated into Sigma Epsilon Engineering Honorary at their fall Dinner-Initiation:

Carlos Alonzo
Ashok Kalelkar
Douglas Jones
Arthur Crenshaw
George Devilbiss
Frank McGee
Mendel Peterson

SIGMA TAU

Xi Chapter of Sigma Tau Engineering Honor Fraternity will hold a mixer, open to the entire School of Engineering and Applied Science, on Wednesday, November 21, at 8:00 p.m., in room 200 of Tompkins Hall. The purpose of the mixer is to present keys to newly initiated members.

The guest for the evening, Mr. R. R. Stootsberry, Chief, Natural Resources Branch, Special Technical Services Division of the Internal Revenue Service, will speak on his experiences in oil wildcatting. Mr. Stootsberry will also be initiated to alumnus membership in the fraternity.

THETA TAU

Theta Tau began its year with a candidate-brother get-together on Wednesday, October 10. Attended by more than twenty-five students eligible for Theta Tau, the function introduced the students to the brothers of Gamma Beta and to the activities of the fraternity. Outstanding fall activities include a pledge mixer, Friday, October 26; the annual shrimp feast, Monday, November 12; and the Fall Initiation Banquet and Ball, Saturday, November 17. Gamma Beta anticipates a visit from Brother Robert E. Pope, Grand Scribe of Theta Tau, during this latter time.

Newly appointed officers handling the above and other activities of the chapter include: Douglas Jones, Pledge Master; Harvey Flatt, Social Chairman; Jerry Edward, Professional Development Committee Chairman; John Pyle, Inner Guard; Vance Cribb, Outer Guard; and Fred Hood, Marshal. These and other brothers of the chapter are looking forward to the 24th Biennial Theta Tau Convention to be held December 27-30, in Louisville, Kentucky.

ENGINEERS' MIXER

This year the annual Engineers' Mixer was held October 3 in room 200 of Tompkins Hall. The event was sponsored not only by the Engineers' Council, as was its predecessors, but also by the student branch chapters of the professional engineering societies, AIEE-IRE, ASCE, and ASME. In addition, this year the event was opened to the entire student body and faculty membership of the School of Engineering and Applied Science.

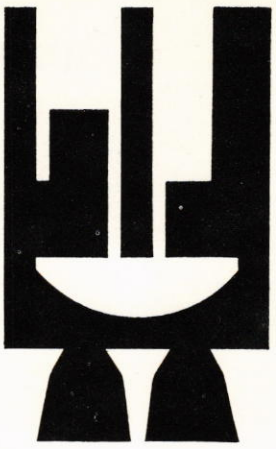
Close to 100 people sat in chairs or on tables, or stood against the walls while Eliot Cohen, coordinator and Master of Ceremonies for the Mixer, introduced the speakers for the evening. One of the highlights of the event was the presentation by Erling Jacobsen, in behalf of Sigma Epsilon Engineering Honorary, of the pictures and bibliographies of two men influential in the field of engineering. This pair of pictures was the third such set to be accepted by Dean Mason for the Engineering School in as many years, and Sigma Epsilon hopes to continue contributions of this type to the school for many more years.

Speakers at the event included Dean Martin A. Mason and the Faculty advisors to the societies and organizations in the Engineering School. After the speeches, the crowd adjourned to the back of room 200 where refreshments were being served. Then, for more than an hour, students and faculty conversed on subjects ranging from class work to membership in the professional engineering societies.

--Continued on Page 14

CALENDAR OF EVENTS

November		November	
1	Homecoming Musical	8	Special Student Council Referendum and Elections
2	Homecoming Float Parade, 1:00 p.m. Homecoming Football Game, 8:00 p.m.	10	Fall Concert — Lisner Auditorium
3	Homecoming Ball	12	Theta Tau Shrimp Feast
4	Intramural Football Game, 2:30 p.m.	14	Theta Tau Business Meeting
7	Professional Society Meetings, 8:15 p.m. AIEE-IRE — Demonstration of Flac II ASCE — Speaker for the evening is Mr. Dennis Carter ASME — To be announced Special Student Council Referendum and Elections	17	Theta Tau Fall Initiation Sigma Tau Fall Initiation
		21	Sigma Tau Open Meeting
		28	Engineers' Council Meeting, 8:15 p.m.



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TECH NEWS

THE MATERIALS REVOLUTION!

"The recent announcement that a form of glass has been developed which is flexible and so strong that it can be thrown to the ground from a ninth-story window without breaking illustrates that ....."

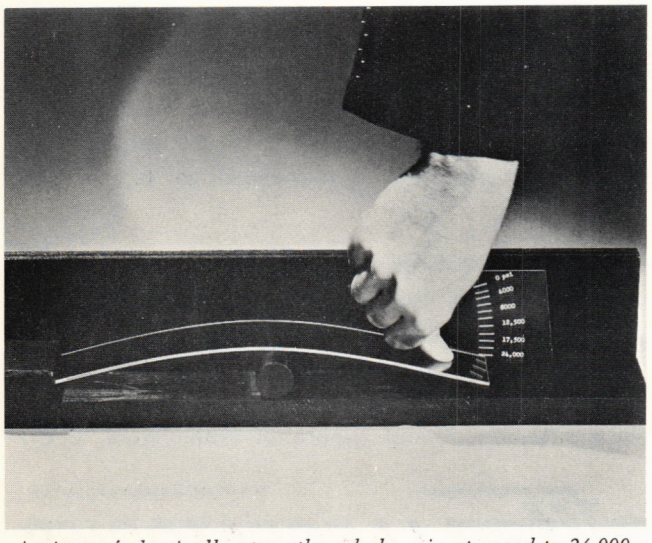
THE NEW YORK TIMES
September 23, 1962

Edited by Clifford B. Stearns

The research laboratories of Corning Glass Works have produced a wide range of ultra-high strength glasses by applying a newly developed chemical process. Corning calls this new basic glassmaking process Chemcor. This treatment involves several different chemical strengthening techniques.

The key to the strength of glass is in its amorphous structure. A piece of glass can be regarded as a single molecule, a three-dimensional polymer in which the strength is equal to the interatomic bond strengths. As long as the surface is free from flaws, glass can be extremely strong. The tensile strength of unabraded glass fibers has been measured at 1,000,000 pounds per square inch; quarter-inch glass rods measure at 40,000 psi. However, the useful strength of glass has always been a small fraction of the theoretical because any contact with hard surfaces produces surface scratches in the glass. These become sites of highly concentrated stress when the surface is put into tension. Since the glass does not flow as metals do to relieve the local stress, a relatively low overall tension is sufficient to extend a scratch into a major crack.

Glass products are annealed to reduce residual stresses to an insignificant value. This process involves, (1) raising the temperature of the glass body, (2) maintaining this temperature for a sufficient time to relieve existing stresses and to stabilize the glass, and, (3) cooling the glass at a rate sufficiently slow so that residual stresses will not reappear when the glass temperature has reached equilibrium. Another method employed by the glass industry has been chill tempering. By tempering, glassmakers can make articles two to four times stronger than annealed products. The principle involved is that the tensile strength increases proportionally with the previously induced compressive stress in the surface layer of the glass. Thus, the effect is that glass breaks from tension and never from compression. When performing this chill tempering, the object involved is cooled rapidly from just below its softening point. Since the inner portion cools more slowly than the surface, it continues to contract after the surface is essentially rigid. Thus, compressive stresses develop in the surface layer with compensating tensile stress in the interior. This tensile stress is not harmful since it is buried. This chill tempering is capable of inducing compressive stresses up to about 20,000 psi under practical conditions. The process is limited, however, to relatively thick pieces of glass and simple shapes because of heat-flow problems. Its strengthening effect is lost if the glass is reheated to above 200-400 degrees C, depending on the composition.



A piece of chemically strengthened glass is stressed to 24,000 pounds per square inch.

The new approach developed by Corning Chemical Engineers is essentially chemical tempering. The Chemcor system, however, is free of the limitations imposed by heat-flow problems. It has two chemical strengthening techniques included which involve forming transparent polycrystalline layers within the surface of glasses. The crystallized skin, which is grown at a high temperature, has a negative thermal expansion and thus expands as it cools. The shrinking of the internal glass induces an extremely high compression of the skin, resulting in high strength (The diagrams at the right shows how one of the chemical strengthening techniques compares with physical strengthening by tempering.).

Because of the extreme strength exhibited by some of the strengthened glasses, sheets of the glass have been bent repeatedly into relatively short radius arcs without failure. A sheet of one type of Chemcor glass, 0.100 inches thick, was flexed without damage 1000 times over a form with a radius of 30 inches.

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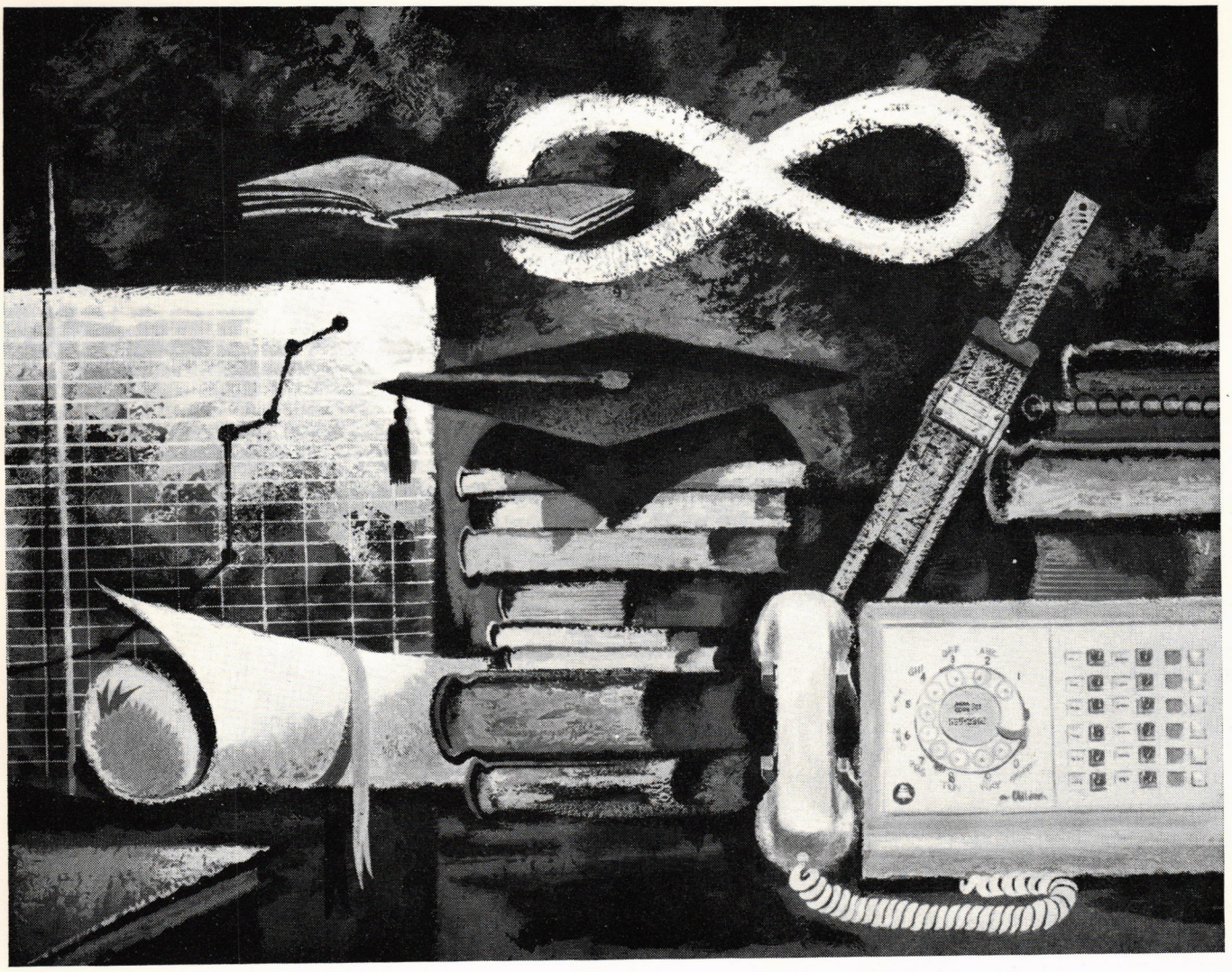

Learning never stops for engineers at Western Electric

There's no place at Western Electric for engineers who feel that college diplomas signify the end of their education. However, if a man can meet our quality standards and feels that he is really just beginning to learn . . . and if he is ready to launch his career where learning is an important part of the job and where graduate-level training on and off the job is encouraged – we want and need him.

At Western Electric, in addition to the normal learning-while-doing, engineers are encouraged to move ahead in their fields by several types of educational programs. Western maintains its own full-time graduate engineering training program, seven formal management courses, and a tuition refund plan for out-of-hours college study.

This learning atmosphere is just one reason why a career at Western Electric is so stimulating. Of equal importance, however, is the nature of the work we do. Our new engineers are taking part in projects that implement the whole art of modern telephony from high-speed sound transmission and solar cells, to electronic telephone offices and computer-controlled production techniques.

Should you join us now, you will be coming to Western Electric at one of the best times in the company's history. In the management area alone, several thousand supervisory jobs are expected to open up to W.E. people within the next 10 years. And our work of building communications equipment and systems becomes increasingly challenging and important as the communications needs of our nation and the world continue to increase.

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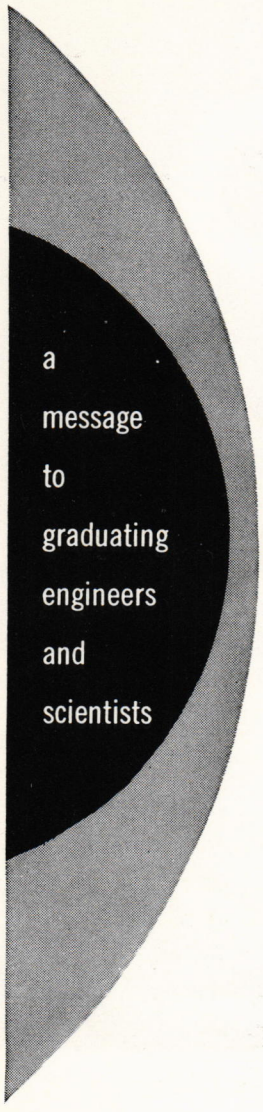

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The challenge of the future is indicated by current programs. Presently Pratt & Whitney Aircraft is exploring the areas of technical knowledge in *magnetohydrodynamics . . . thermionic and thermoelectric conversions . . . hypersonic propulsion . . . fuel cells* and *nuclear power.*

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EFFECTS OF MODULATION ON AN OSCILLATOR

by Donald Abram Miller

A cathode-coupled symmetrical multivibrator, which has capacitive coupling between the two cathodes, is used for certain fuzing applications. It was desired to know if the circuit could be frequently modulated and used for secondary purposes. It was found that a method of signal injection involving the cathode coupling network could produce in excess of 50% frequency deviation.

The cathode-coupled symmetrical multivibrator, which has capacitive coupling between the two cathodes, is a source of high amplitude symmetrical square wave signals. Of the three RC coupling networks, cathode to cathode and the two plate to grid, it is desirable to make the time constant of the former network the smallest of the three so that the timing action will occur in the cathode network.

Such a circuit (Fig. 1) is used in certain fuzing applications. It was desired to know if the circuit could be frequency modulated and used for secondary applications.

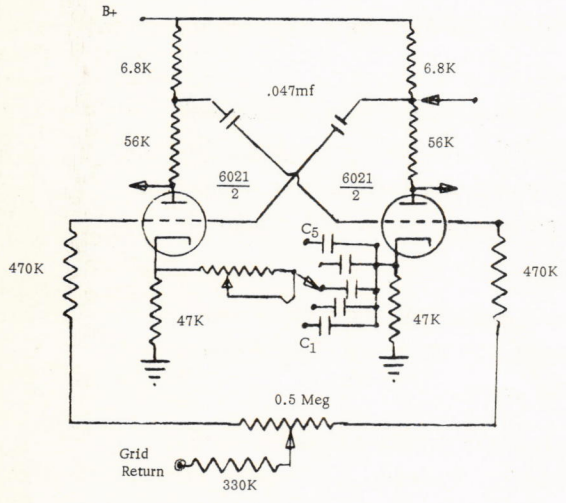


FIGURE 1

METHODS FOR SIGNAL INJECTION

The frequency of a multivibrator is dependent on many parameters including those of plate supply and grid return voltages. The curves of Fig. 2 show the changes in frequency caused by variation of these voltages. The curve made with variable grid return voltage and constant plate supply voltage suggested a method for modulation. When auxiliary hardware was attached to the basic circuit, changes in frequency did occur, but the general shape of the curve was not greatly altered.

The curve for variable grid return voltage is very linear between cut-off and about 20 volts. The first method of signal injection investigation consisted of biasing the grid return point into the middle of this linear region and then superimposing a sine wave signal (Fig. 1).

The second method of signal injection consisted of connecting a high resistance between the plate sides of the two plate to grid capacitors (Fig. 1). The signal was then brought through a

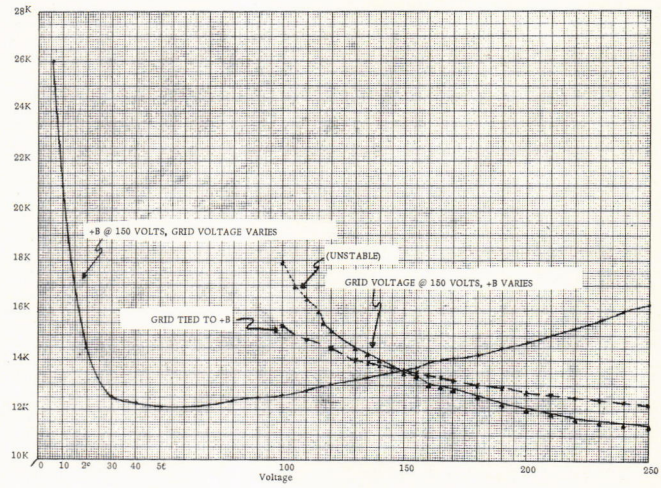


FIGURE 2

D. C. isolating capacitor to the center of this large resistance value.

The third method for signal injection involved the cathode coupling network (Fig. 1). The capacitance value was divided into a relatively large and a small value. The signal was then injected at the center of the smaller capacitance value.

In all three methods, the symmetry of the circuit was maintained.

MEASURING PERCENT FREQUENCY DEVIATION

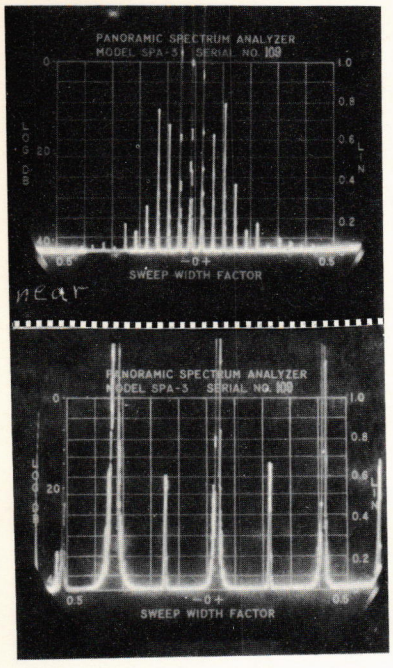
A technique was needed for measuring the percent frequency deviation. A panoramic spectrum analyzer was one apparatus used. A typical spectrum display is shown in Fig. 3-a on the linear scale.

Fig. 3-b shows an expanded display of some of the lower harmonics. When the square wave is modulated, the lines on the analyzer display, representing the harmonics, seem to thicken (Fig. 4-a). If the fundamental varies a certain amount, the second harmonic varies twice as much, and so on. Consider the amount of frequency variation of the fundamental and call it Δf_p, where the subscript p denotes peak value. The variation in the nth harmonic will be $n\Delta f_p$ and in the $(n + 1)$th harmonic, $(n + 1)\Delta f_p$. If the modulation is such that the broadening of the nth harmonic just meets that of the $(n + 1)$th harmonic (Fig. 4-a), then $n\Delta f_p + (n + 1)\Delta f_p$ = separation of harmonics = F_c, the carrier or fundamental frequency. The percent frequency deviation can then be found as $\frac{2\Delta f_p}{F_c} \times 100 = \%$ dev.

Unfortunately, the spectrum analyzers available did not give good resolution at the lower frequency ranges considered.

An oscilloscope was one apparatus used for measuring percent frequency deviation. A one cycle display, without modulation, is shown in Fig. 4-b, and with modulation in Fig. 5-a.

If a display of some periodic waveform spans the screen of an oscilloscope horizontally, the horizontal dimension D of the screen is also equal to mT where m is the number of cycles shown (not necessarily an integer) and T represents the period. For convenience, m was made a multiple of 1/2 and mT = D was confined to just



A

B

FIGURE 3

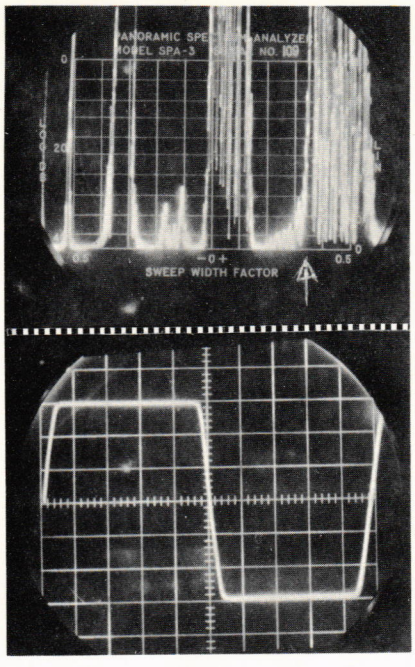
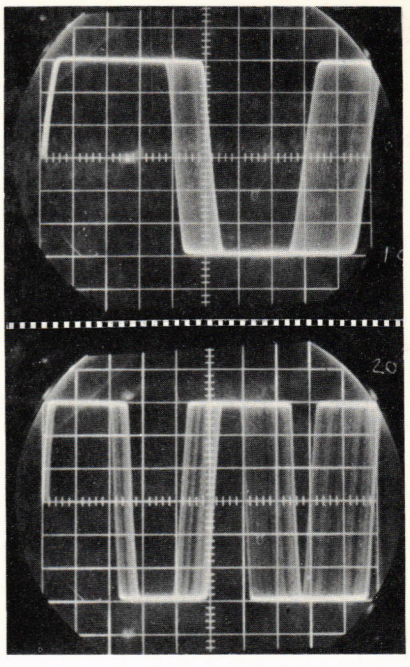


FIGURE 4



A

B

FIGURE 5

equal the 10 ruled divisions on the screen. Since the portion of the wave which touched the tenth graduation before modulation was of vertical slope, the deviation in period (from FM) manifested itself in a broadening of this vertical line whose expanded width will be called d. Then $\frac{d}{mT} = \frac{d}{D}$ is of the same ratio as $\frac{\Delta f}{Fc}$ where Δf is the peak to peak value. Here, $\frac{\Delta f}{Fc} \times 100 = \%$ dev.

Of course, since every vertical portion of the waveform, except the first one which is locked on by the synchronizing circuit of the oscilloscope, is broadened by the modulation, any choice of mT and corresponding d could be used. Making mT = D, the full horizontal spread of the screen graduations, (1) provided largest available magnitudes for accuracy in measurement and (2) kept the denominator of the expression $\frac{d}{mT} = \frac{d}{D}$ at the convenient value of ten. A comparison of Figs. 5-a and 5-b shows that the same value of percent deviation is obtained for different values of m (viz, m = 1 and m = 2).

Simultaneous displays were used for quantitative comparison between the methods involving the two types of apparatus, the spectrum analyzer and the oscilloscope. The maximum discrepancy between the two methods was within experimental error. Therefore, the technique involving the oscilloscope was considered valid for all the frequency ranges encountered.

To facilitate measurement of the frequency modulation effects, a zener diode clipper, which saturated at 17 volts peak to peak, was used to suppress the amplitude modulation effects.

Quantitatively, the results of this experiment depended on clipping level, signal voltage, and signal frequency. The signal generator provided sine waves from 10 c.p.s. to beyond carrier frequency at a maximum output of 38 volts peak. The signal generator used had a low internal impedance to ground.

The first method of signal injection, involving the grid return point, and the third method, involving the cathode coupling network, both affect the parameter of grid to cathode voltage. The grid to ground voltage (first method) and the cathode to ground voltage (third method) sum to the grid to cathode voltage.

The second method of signal injection, involving the plate to grid coupling networks, affects the parameter of plate to cathode voltage.

The first two methods do not merit extensive discussion. With the grid return point biased into the linear region on the curve of Fig. 2, as previously mentioned, the circuit was most sensitive to modulation only at frequencies of the order of 40 c.p.s. or less. It was noticed that the circuit was also sensitive for a grid return bias of about 300 volts and responded to higher frequency inputs. However, the maximum percent frequency deviation was about 2%.

The second method required biasing similar to that of the first, but showed response to signals in excess of 200 c.p.s. The percent deviation was very constant over the variation in bias voltages and signal frequencies. However, the maximum percent frequency deviation was 2%.

The third method of signal injection produced satisfactory results in which two peaks in sensitivity occurred. One was for a grid return potential of 40 to 50 volts and the other for a potential of about 290 volts.

This method followed a pattern similar to that of the other two methods in that there was a relative sensitivity at the middle bias voltages, reaching an even higher region of sensitivity as the bias approached 300 volts. The use of sufficiently high input frequencies produced percent frequency deviations in excess of 50%. For example: by using a grid return bias of 300 volts and a signal of 35 volts peak, 850 c.p.s. on a carrier frequency of 22.2 KC, 66% frequency deviation was obtained.

--Continued next page

EFFECTS OF MODULATION ON AN OSCILLATOR — Cont. from page 13

The triodes were in cathode coupled configuration. The fact that very large voltages on the grid return point (Fig. 1) produce no more than 45 volts on the grid itself suggests that grid current is drawn. That the grid is zero or positively biased with respect to the cathode in some regions was substantiated by measurements.

It should be pointed out that with the plate supply at 150 volts and the grid return at 290 volts or higher, the oscillator would restart if the plate supply were turned off and then on but not if the same were done to the grid return voltage. The oscillator could be restarted at a lower grid return voltage and then brought back to the same operating level.

It was desired to know if the multivibrator circuit of Fig. 1 could be frequency modulated and used for secondary purposes. The best point on the circuit for signal injection was found to be at the center of the capacitance value of the cathode coupling network. Percent frequency deviations in excess of 50% were obtained. This method of modulation was considered satisfactory.

CAMPUS NEWS — Continued from Page 6

ENGINEERS' COUNCIL ELECTIONS

The newly elected representatives to the Engineers' Council are:

Vytas Tarulis, Sophomore Representative
Martin Murdock, Freshman Representative
John Starke, Freshman Representative

Elections were held on October 19, 1962

INTRAMURAL SPORTS

Football: To date, the Engineers Team has played one football game in the fall series. Paul Fleming ran for two touchdowns, and Vytas Tarulis returned a punt for a third touchdown as the Engineers walked off with the game against the ROTC team, 24-7. The next game to be played will pit the strength of the Engineers against that of the School of Pharmacy.

Ping Pong: Of the five men who have played in behalf of the School of Engineering and Applied Science, Vytas Tarulis, John Hall, Richard Singer, Tom McIntosh, and Paul Fleming, Richard Singer was the one who made it to the semi-finals. Further news on this event will appear in the next issue.

Coming Events: There are at least three more intramural events which will occur this year: basketball, foulshooting, and bowling. Be sure to watch the main bulletin board for further notices.

OPEN LETTER . . . .

I wish to present, for your consideration, an idea which evolved through discussions with several of our faculty. Please keep in mind that, as Dean Mason has said, even a very busy faculty will find time to implement a program of benefit to its student body, provided that student support is demonstrated by continual student participation. However, a program which has the promised good attendance at the first meeting, followed by a rapidly diminishing participation, is not only disappointing to the faculty at large, but is also frustrating to the co-operating faculty members.

I know that one is often prompted to ask questions which, because of limitations posed by the aims of the course or because of time limitations, are not satisfactorily covered in class. Sometimes the student is able to find the desired answers outside of class, but usually such thoughts are necessarily shoved to the back of the mind, merely to be forgotten.

If the students promise their support, the faculty is willing to help improve the situation. Perhaps, in order to secure a time at which a sufficient number of students can attend, it may even be necessary to hold a "bag-lunch bull session." The get togethers might consist of semiformal lectures based on questions selected from those submitted by students, informal question and answer periods limited to a pre-selected field or discipline, or formal lectures representing a survey of the current "state-of-the-art." Depending on the depth of coverage in the program, extra academic credit might accrue to participants.

Please send your comments and opinions to me in care of T.H. 209 or the MECHELECIV mailbox in the D-H House. If a sufficient number of students promise their support, and if a common meeting time can be agreed upon (at what ever frequency of occurrence), the faculty will be invited to formulate a definite plan of operation.

Let me hear from you very soon.

Sincerely yours,

Donald A. Miller

Donald A. Miller

ASME

MECH MISS

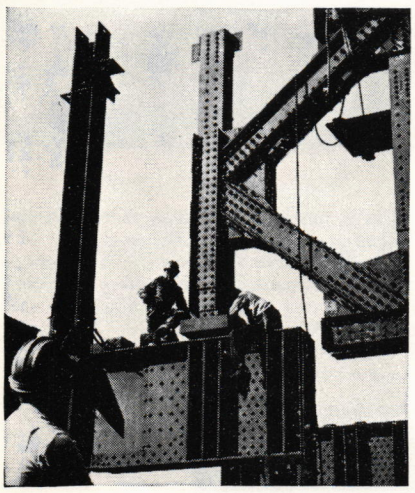
Susanne Ritter

This month's Mech Miss is entrancing Susanne Ritter. A senior in the School of Education, she is currently co-captain of the cheerleaders, president of Pi Beta Phi Sorority, and president of Delphi Women's Honorary. Among her many interests, Susanne enjoys working with people and participating in outdoor sports of which the most outstanding is sailing.
After graduation, Susanne plans to live in South America for a few years "to relax and enjoy the continent."

Opportunities are better than ever at Bethlehem Steel!

What kinds of engineers do you find with Bethlehem?

Here's the answer: Chemical Engineers . . . Civil Engineers . . . Electrical Engineers . . . Industrial Engineers . . . Mechanical Engineers . . . Metallurgical Engineers . . . Mining Engineers . . . Naval Architects and Marine Engineers, and more.



Every major engineering degree is represented within the management ranks here at Bethlehem Steel.

It makes sense. The mining and processing of minerals obviously suggest the need for Mining Engineers. Then come the chemical processes of coke-making, smelting, refining. Fuels are consumed, valuable by-products are made. Is it any wonder steelmaking calls for Chemical Engineers?

And how about the machinery, the mills, the furnaces, the instrumentation that make up a modern steel plant? Mechanical Engineers design them, and frequently supervise installation. Civil Engineers design and put up the buildings to house them, and the feed lines to keep them supplied.

Power? Steel is the biggest industrial consumer of electric power. You cannot conceive of a greater concentration of electrical equipment than in a modern steel mill. And many steel plants *generate* electric power, too. Electrical Engineers are busy fellows in the steel industry.

Steelmaking calls for volume production, complex and scientific, often highly automated. We manufacture numerous finished products, too, from nuts and bolts to nuclear-powered cruisers. The Industrial Engineer finds plenty to do here at Bethlehem.

What's more, the kind of engineering degree does not limit a Looper's assignments. The superintendent of a huge open-hearth department, or a giant rolling mill, might well be an M.E., a Ch.E., a Met.E., an I.E., or C.E.

Sales Engineers

Because of the nature of our products, a man with a technical background and a "sales personality" has a great opportunity in sales with Bethlehem Steel.

Research

Our research policy and our magnificent new research laboratories, in Bethlehem, Pa., offer unexcelled opportunities for research and development engineers and scientists. The exciting results of research promise bright prospects for all Bethlehem operations.

Shipbuilding

As the world's largest privately owned shipbuilding and ship repair organization, Bethlehem offers careers to Naval Architects and Marine Engineers, as well as to engineers in many other categories.

The Loop Course

This program was established some forty years ago, to select and train well-qualified college graduates for management careers in the Bethlehem organization. It was so named because of an observational circuit (or "loop") of a steel plant. After a five-weeks' basic training period, which is held once a year at company headquarters in Bethlehem, Pa., loopers receive their first assignments, which call for specialized training that may last for a few weeks or for as long as a year. Next comes on-the-job training, and the looper is on his way.

An equal opportunity employer

BETHLEHEM STEEL

It's now a fact: every Ford-built car in '63 has self-adjusting brakes

"Give us a brake," Ford Motor Company engineers were told, "that will automatically compensate for lining wear whenever an adjustment is needed—and make it work for the entire life of the lining."

Tough assignment—but not insurmountable. Today, not only does every Ford-built car boast self-adjusting brakes, but the design is so excellent that adjustments can be made more precisely than by hand.

This Ford-pioneered concept is not complex. Key to it is a simple mechanism which automatically maintains proper clearance between brake drum and lining.

Self-adjustment takes place when the brakes are applied while backing up. This adjustment normally occurs but once in several hundred miles of driving. The brake pedal stays up, providing full pedal reserve for braking.

Another assignment completed—and another example of how Ford Motor Company provides engineering leadership for the American Road.

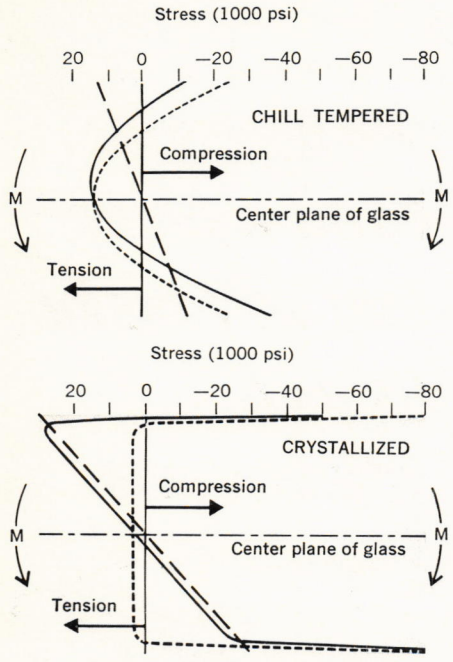
Ford

MOTOR COMPANY

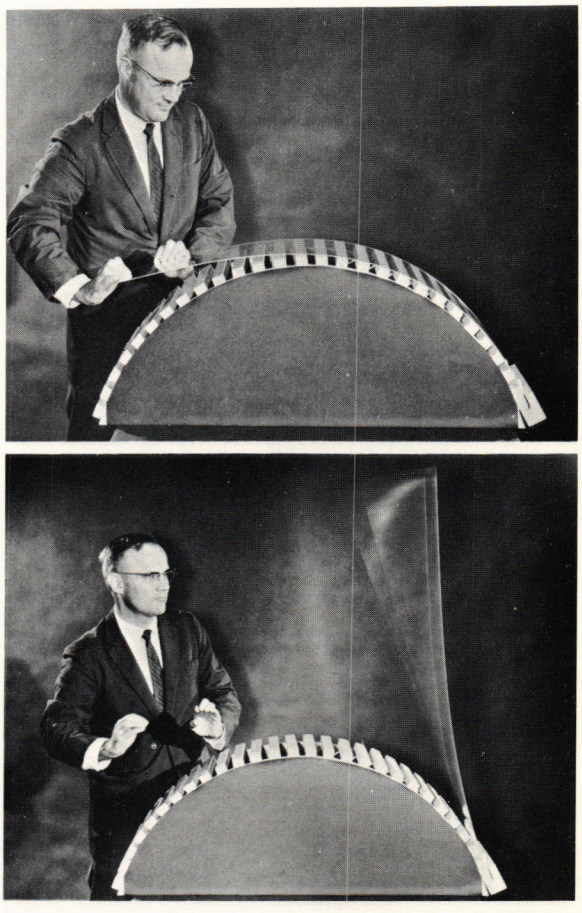
The American Road, Dearborn, Michigan

PRODUCTS FOR THE AMERICAN ROAD • THE HOME THE FARM • INDUSTRY • AND THE AGE OF SPACE

TECH NEWS — Continued from Page 8



Two methods for strengthening glass — tempering and one of the techniques in Corning's new Chemcor system—are compared. In both cases, strengthening is achieved by canceling tensile stress on the surface by pre-stressing in compression. The dotted line is the pre-stress. The dashed line is stress created by external bending load M. Net stress is shown by the solid line. In the chemical strengthening technique, the surface stress in the crystallized glass stays much further into the compression range than in the tempered glass.



Piece of chemically strengthened glass is bent over 20-inch radius and then released. The glass is so tough it can be bent back and forth — even twisted.

This strength quality will make possible the fabrication of lighter weight articles without sacrificing strength. Also, at the same weight, some of the new glasses are expected to be more resistant to breakage than today's glass products. It should be stated that the chemical treatment given the glass under the method in no way affects the basic properties characteristic of glassy materials, i.e., the durability, hardness and smoothness of the surface. In addition to the above mentioned characteristics, the chemically strengthened glasses can be made optically clear and highly transparent, translucent or opaque. The glasses have dimensional stability, and they do not discolor with age or in any way deteriorate. Finally, these glasses are made from non-strategic, readily-available raw materials (These materials being mixed, melted and shaped by standard glass-making methods.). The strengthening treatment is applied after the glass object has been fabricated and finished. Someday these properties will lend themselves to mass production by automatic, high-speed glassmaking equipment.

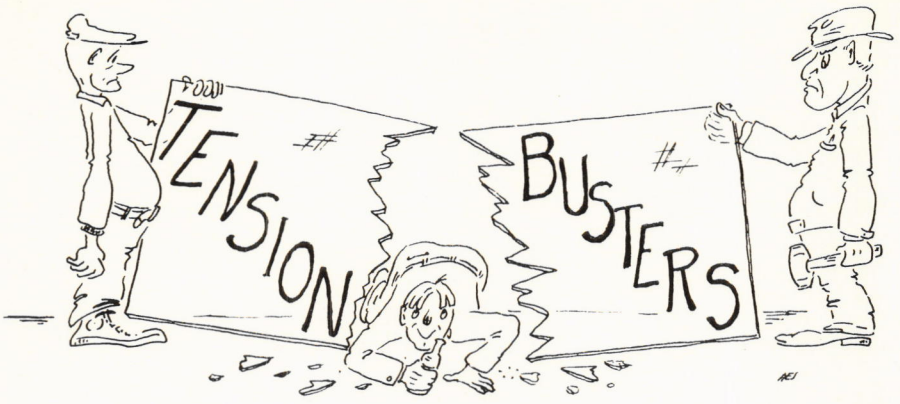
INDEX TO ADVERTISERS

One day during a war, a tall, strong and handsome Roman soldier broke into a house where he found two luscious maidens and their matronly nurse.

Chuckling with glee, he roared, "Prepare thyselves for a conquest, my pretties."

The lovely girls fell to their knees and pleaded with him, "Do with us as thou wilt, O Roman, but spare our faithful old nurse."

"Shut thy mouth," snapped the nurse. "War is war."



Tell me, Bob, who was that lady I saw you outwit last night?

An ME spoke to a coed and asked her if she was doing anything that night. She said she wasn't so he took her out and she wasn't.

Then there was the CE who visited a nudist colony. "It was then I knew", said he, "that nothing looked good on her".

The fat EE married a religious cook, so every night for dinner she serves him burnt offerings.

Being fat has a grand advantage: You always know where your ashes are going to fall.

"You and your wife must be ideally suited" said the pastor to one of his flock.

"What makes you say that"? was the reply.

"Isn't it obvious"? answered the pastor. "You already have twelve children and your wife says that she is expecting another".

"Listen father", said he. "Bertha and I don't get along at all. As a matter of fact I am frightened to death of her. I am telling you father, she is a vicious barracuda."

"I don't understand" said the pastor," if that is the case, why do you have so many children"?

"As a safety measure, father." This way I can always get lost in the crowd."

Coed: "How was your date with Bob last night?"

Another coed: "He fascinated me so I kissed him. Then he began to unfascinate me so I slapped him".

Everyone claims that liquor shortens a man's life, but one must remember that a drunk sees twice as much in half the time.

The boss told the secretary that he would pay her eighty dollars with pleasure. However, she didn't take the job. With pleasure she wanted a hundred.

During a holiday sale, prices were so low that by early morning a long line had gathered.

Down the street came a little man who walked to the locked entrance and stepped before the big bruiser who was first in line. The brute was so enraged that he picked up the little man and threw him to the end of the line. The little man picked himself up, dusted himself off, and once more attempted to step before the big fellow at the head of the line. Once again, however, he ended sprawling on the sidewalk.

After three more tries and as many rebuffs, the little man walked up to the big brute and wagging his finger under the bruisers nose he said: "You throw me down once more, and so help me, I won't open the shop".

Mary had a little swing,
It wasn't hard to find,
for everywhere that Mary went,
That swing was just behind.

Her feet were up in the air.
Her face turned crimson red,
She felt both cold and wet,
And she wished that she were dead.
Now the moral of my story is,
Never sit down abrupt,
Always look behind you . . .
The seat may still be up.

A drunk in the Empire State Building stepped into an elevator shaft and dropped thirty stories to the basement. A bell boy, horror stricken, looked down into the shaft, and heard a faint cry, "Don't flush it! Don't flush it!"

The young man started work as a stockroom boy. Within six months he was made a salesman. In another six months he was upped to sales manager, and shortly thereafter he was made general manager.

A few days later, he was called in by the president of the firm, who explained that he would soon turn over the presidency to the newcomer.

"Thanks," said the young man.

"Thanks!" growled the president.

"You've been with this firm only a year. Is that all you can think of to say?"

"Well," said the young man, "thanks a lot, dad."

The folks in the next apartment must have had a big blow-out last night. They hollered and pounded on the walls until 2 a.m. Luckily, I was up late practicing on my drums, so they didn't keep me awake.

When asked how it felt to attend the dedication of his own statue, the honored man said, "Well, somehow, you begin to feel differently about pidgeons."

Two co-eds were discussing their favorite subject: men.

"If I came home and found an engineer in my apartment," grasped the freshman, "I wouldn't know what to do."

"You could give him forty-eight hours to get out," suggested the senior.

Kodak beyond the snapshot...

(random notes)

Resist education

A certain engineering college recently asked us for a contribution not of money but of a small object suitably symbolic to deposit in the cornerstone of a new building. After thinking about it a bit, we sent three intricately shaped bits of metal so small that one of them got lost and never found its way into the box that will be opened some day to show our descendants the topics that engineers in 1962 regarded as fresh and promising. Is it not true that the engineering mind today is much occupied with working metals and semiconductors in ways to get as much performance as possible from as little bulk as possible?

Doggone right. In addition to making deposits in cornerstones, we have been busy expanding the line of photosensitive resists on which this hot new art so strongly depends. Everybody in it should be delighted to learn of KOR, a new one that's 10 to 15 times as sensitive to arc light and 30 to 100 times as sensitive to tungsten light as Kodak's well-known resist, KPR. This opens up the possibility of exposing KOR by a projected image instead of by contact printing, but the photographic speed is still a little low for an ordinary enlarger. A high-intensity projection printer will turn the trick.

If you don't even know what we are talking about, you have a dangerous blind spot in your education which you could repair quickly by sending a buck to Eastman Kodak Company, Rochester 4, N.Y. for a copy of "Photosensitive Resists."

Cheaper than rubies maybe

We have entered the laser rod business. This decision looks logical enough. Lasers are a) very, very, very promising and b) connected by a strong thread to a technology about which we feel cocky —namely, non-silicate rare-earth glass, which we broke open commercially 25 years ago for photo lenses.

It was a thrill to hear that a rod of ours commenced action at a threshold of only 4 joules at room temperature. It emitted at 1.06μ by transition of Nd^{+++} from $4F_{3/2}$ to $4I_{11/2}$ (not down to ground state, which is $4I_{9/2}$). Its time to technological obsolescence will be inevitably and indubitably short.

Meanwhile, for the people busy feeling out the ground rules of laser engineering for machine tools, weapons, etc., our neodymium-boron-barium-lanthanum-thorium-strontium glass is a good first choice because 1) neodymium needs no refrigerants (fluorescence doesn't return Nd^{+++} to ground state); 2) 1.06μ is convenient to phototubes, phosphors, and photography; 3) threshold for laser action comes at ⅓ the energy input that Nd^{+++} needs in silicate glass.

You have heard of ruby lasers? They depend on Cr^{+++}. Cr^{+++} depends on the crystal field to define its energy levels. Rare earths don't need a crystal field because their 4f levels are shielded by 5s electrons. Therefore they can work in glass, which can come big and homogeneous. Already a 2" x ¼" rod with ends tuned to reflect ~100% and 98% at 1.06μ costs less than a decent used motorcycle.

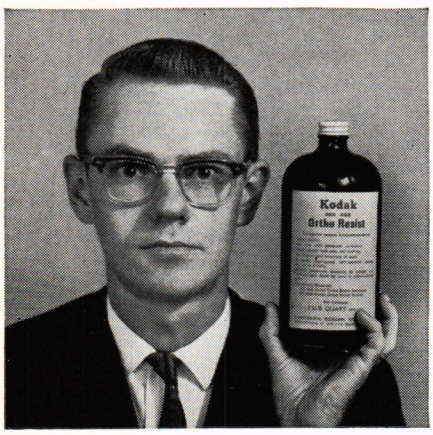
Adhesive findings

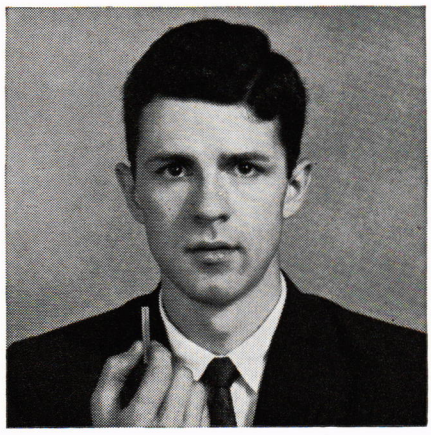
Mr. Guy V. Martin, 110 Yale Blvd., S.E., Albuquerque, N.M., has found EASTMAN 910 Adhesive vastly superior to soft solder for transmitting ultrasonic vibration. He has used up to 60 kc and electrical power inputs up to 200 watts at temperatures up to 200°F.

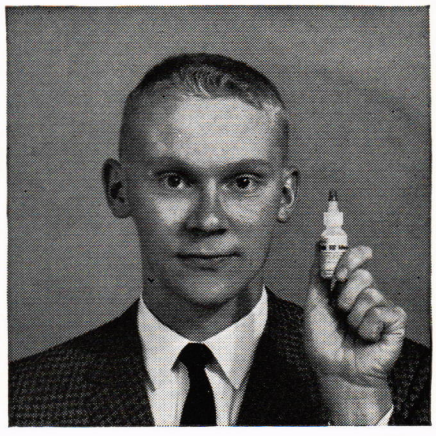
When he feeds energy like that through a solder bond from a transducer of laminated nickel sheets to an application tip, the solder deteriorates progressively and the transmission drops steadily. An EASTMAN 910 bond acts differently. Without apparent change, it transmits three to four times as long as solder takes to reach disintegration.

When the 910 bond finally snaps, it does so all at once with an audible snap. In the case of aluminum bonded to the nickel, rupture always takes place between the adhesive film and the aluminum. With other metals, plastics, ceramics, or glass bonded to the nickel, the rupture divides itself between one interface or the other and doesn't appear within the film.

Mr. Martin claims that for some 30 years Kodak has been very obliging in furnishing him helpful information from time to time. We claim that in volunteering his adhesive findings, he has now amply repaid us. We shall be very happy to furnish you, too, with helpful information for 30 years. EASTMAN 910 Adhesive is obtainable in a $5 sample kit from Eastman Chemical Products, Inc., Kingsport, Tenn. (Subsidiary of Eastman Kodak Co.). It develops great strength within seconds.





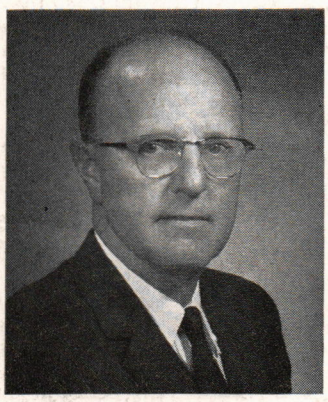


ALL SORTS OF PRODUCTS, ALL SORTS OF CAREER DEDICATION AT KODAK FOR THE SCIENTIFICALLY ORIENTED, B.S., M.S., OR PH.D.

EASTMAN KODAK COMPANY

Rochester 4, N.Y.

AN INTERVIEW WITH G.E.'s DR. GUY SUITS, VICE PRESIDENT AND DIRECTOR OF RESEARCH



Dr. Suits has managerial responsibility for the General Electric Research Laboratory and as a member of the Company's Executive Office he is directly concerned with G.E.'s over-all research programs and policies. He joined G.E. in 1930 as a physicist, and holds 76 patents, is Chairman of the Directors of Industrial Research, member of the National Academy of Science, Director of American Institute of Physics, previous Chairman of Naval Research Advisory Committee and Fellow of the AIEE, AAAS, and IRE, and has been Vice President and Director of Research since 1945.

For complete information about these General Electric training programs, and a copy of Dr. Suits paper "The New Engineer And His Scientific Resources," write to: Personalized Career Planning, General Electric Company, Section 699-05, Schenectady 5, New York.

How Scientists and Engineers Work Together in Industry

Q. Dr. Suits, I've heard a good deal about the scope of your programs. Is your research mostly in physics and electronics?

A. This is a common misconception. The work of the many laboratories of General Electric "covers the waterfront" in science and in advanced engineering technology. Some laboratories specialize in electronics research, others in atomic power, space technology, polymer chemistry, jet engine technology, and so forth. Actually, the largest single field represented by the more than 1000 Ph.D. researchers in General Electric is chemistry.

Q. Is this research performed principally by people with Ph.D. degrees in science?

A. General Electric research covers a broad spectrum of basic and applied work. At the Research Laboratory we focus largely on basic scientific investigations, much as in a university, and most of the researchers are Ph.D.'s. In other Company laboratories, where the focus is on applied science and advanced engineering, engineers and scientists with B.S. and M.S. degrees predominate. Formal college training is an important preparation for research, but research aptitudes, and especially creative abilities, are also very important qualities.

Q. What are the opportunities for engineers in industrial scientific research and how do scientists and engineers work together in General Electric?

A. Classically, engineers have been concerned with the problem "how," and scientists with the question "why." This is still true, in general, although in advanced development and in technological work scientists and engineers work hand-in-hand. Very close cooperation takes place, especially in the increasingly important fields of new materials, processes, and systems. Certainly in General Electric, a person's interest in particular kinds of problems and his ability to solve them are more important than the college degree that he holds.

Q. What does it mean to an engineer to have the support of a large scientific research effort?

A. It means that the engineer has ready access to the constant stream of new concepts, new materials, and new processes that originate in research, and which may aid his effort to solve practical problems. Contact with research thus provides a "window" on new scientific developments—world-wide.

Q. How does General Electric go about hiring engineers and scientists?

A. During each academic year, highly qualified technical people from General Electric make recruiting visits to most college campuses. These men represent more than 100 General Electric departments and can discuss the breadth of G.E.'s engineering and science opportunities with the students. They try to match the interests of students and the Company, and then arrange interview visits. The result of this system is a breadth of opportunity within one company which is remarkable.

Experienced technical people are always welcome, and they are usually put in contact with a specific Company group. Where no apparent match of interests exists, referrals are made throughout General Electric. In all cases, one finds technical men talking to technical men in a really professional atmosphere.

Q. Are there training programs in research for which engineering students might be qualified?

A. There certainly are. Our 2-year Research Training Program at the General Electric Research Laboratory gives young scientists a chance to work with experienced industrial research scientists before carrying out research and development on their own.

In addition, there are seven Company-wide training programs. Those that attract the largest number of technical graduates are the Engineering and Science, Technical Marketing, and Manufacturing Training Programs. Each includes on-the-job experience supplemented by a formal study curriculum.

Of course, not all graduates are hired for training programs. In many cases, individuals are placed directly into permanent positions for which they are suited by ability and interest.

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